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Rec'd PCT/PTO 21 DEC 2004
10/519013

NEW INTRODUCTION.

Diaphragm valve and open/close element for said valve

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This invention addresses a diaphragm valve, ~~which~~ comprises a valve body, consisting of an inlet sleeve and an outlet sleeve, which have a curved shape and equal circular sections, and converge at least partly to a fluid flow chamber, which contains the valve seat, substantially consisting of the flattened and slightly concave surface of the line of intersection of the two sleeves on the opposed sides thereof, which chamber is divided into two parts with respect to a plane parallel to the plane tangent to the lower apex of the valve seat surface, one part whereof is integrated in the valve body, and is peripherally delimited by a clamping flange, and the other part consists of a bonnet to be sealably secured onto said valve body, which bonnet has a coincident peripheral clamping flange, an elastic diaphragm being provided, made of rubber or the like, which has a peripheral sealing flange to be clamped between the peripheral flanges of said two parts of the chamber, said flange being connected to a central dome-shaped convex part whose convexity is oriented, in an unstressed position, toward the valve seat, and means being provided on the concave side of the diaphragm, facing toward the bonnet, to compress the diaphragm against the valve seat surface in such a manner that, when the diaphragm is compressed against said surface, any fluid flow from the inlet sleeve to the outlet ~~sleeve is prevented whereas, when the diaphragm is~~

<*> ACCORDING TO THE PREAMBLE OF CLAIM 1

08-04-2004

~~lifted and deformed toward the bonnet, free fluid flow is allowed.~~

In such prior art valves, typically in the valve body, the sum of inlet and outlet sections are inscribable in a substantially circular shape or in any such shape that is inscribable in a square, as it is generated by the confluence of two circular and substantially constant sleeves. <*> ~~Therefore, the diaphragms are circular in the concave part and have square flanges. For this reason, these valves have large sizes and considerable space requirements, particularly in the axial direction of flow, and their fabrication requires the use of a considerable amount of metal, resulting in very heavy weight and considerable costs, particularly as flow rates and inlet and outlet sleeve diameters, i.e. overall valve sizes, increase. Furthermore, particularly in hydraulically operated valves, the pressure exerted by the fluid that is piped in the pressure chamber between the bonnet part and the valve closing dome of the diaphragm may cause the diaphragm to bow out, particularly into the outlet sleeve port, wherein no counterbalancing pressure is provided, and this causes the so-called balloon effect. This drawback is also dependent on the considerable length of the radius of the circular diaphragm, when seen in the axial direction of the flow, and more particularly of the long axial diameter of the outlet sleeve port opening into the flow chamber and is particularly serious in large-size valves, operating at very high flow rates~~

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(*) DOCUMENT US 4,319,737 DISCLOSES AN ELLIPTICAL SHAPE OF THE INLET AND OUTLET SECTION, BUT THE SUBSTANTIALLY ELLIPTICAL SHAPE OF THE INLET AND OUTLET SECTION OF THE VALVE DISCLOSED IN US 4,319,737 ARE COMBINED WITH A CIRCULAR SHAPE AND A SQUARE OR SQUARE-INSCRIBABLE SHAPE OF THE FLANGE.

~~substantially constant sleeves~~. Therefore, the diaphragms are circular in the concave part and have square flanges. For this reason, these valves have large sizes and considerable space requirements, particularly in the axial direction of flow, and their fabrication requires the use of a considerable amount of metal, resulting in very heavy weight and considerable costs, particularly as flow rates and inlet and outlet sleeve diameters, i.e. overall valve sizes, increase. Furthermore, particularly in hydraulically operated valves, the pressure exerted by the fluid that is piped in the pressure chamber between the bonnet part and the valve closing dome of the diaphragm may cause the diaphragm to bow out, particularly into the outlet sleeve port, wherein no counterbalancing pressure is provided, and this causes the so-called balloon effect. This drawback is also dependent on the considerable length of the radius of the circular diaphragm, when seen in the axial direction of the flow, and more particularly of the long axial diameter of the outlet sleeve port opening into the flow chamber and is particularly serious in large-size valves, operating at very high flow rates

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and having wide diaphragm surfaces. The drawback may cause the unsupported diaphragm to be damaged, thereby leading to seal defects and/or opening/closing problems, due to the fact that the diaphragm is only partly resilient or is not resilient at all. In order to obviate this drawback, a rib may be provided in an intermediate position of the outlet sleeve port opening into the flow chamber, which rib is oriented in the flow direction and is substantially perpendicular to the plane tangent to the lower apex of the valve seat. This rib has, at its edge facing toward the dome of the diaphragm, a flattened surface and appropriately curved to prevent the dome from bowing out when the latter is compressed against the valve seat. Nevertheless, this rib causes an increase of the construction complexity of the valve, as well as its weight and cost, and does not solve the problem of the large size, in the flow direction, of prior art valves and, from the functional point of view, leads to a possible build up of filamentary matters.

Therefore, this invention has the object of obviating the above drawbacks, thereby providing, by using simple and inexpensive means, a valve as described hereinbefore, whose diaphragm is not subjected to any abnormal deformation and consequent early wear and/or malfunctioning during use, and has an axial size, a weight and fabrication costs that are lower than in prior art valves.

The invention achieves the above purposes by providing a valve ~~as described hereinbefore, in which~~ ACCORDING TO THE PREAMBLE OF CLAIM 1 IN COMBINATION WITH THE FEATURES OF THE CHARACTERIZING PART OF CLAIM 1

~~the cross section of outlet and inlet sleeves, at the ends opening into the flow chamber,~~ and ~~that~~ in which the valve seat, is flattened in the direction of flow, i.e. along the axis that joins the centers of the two inlet and outlet ends of the sleeves, opening into the flow chamber, and is elongated in a direction transverse to the direction of flow, particularly having a substantially elliptic shape, or anyway inscribable in a substantially rectangular peripheral clamping flange, and with the longer side disposed in a direction transverse to the direction of flow. Hence, the peripheral flange of the diaphragm may have a corresponding rectangular shape, inscribing the central convex portion of the diaphragm, which consists of an element having the shape of a sector of an ellipsoid or similar, whose section plane is disposed in such a manner as to correspond with the flow chamber port.

It shall be noted that the inventive concept defined as "flattened in the flow direction" includes all diaphragm valves and all diaphragm-like open/close elements in which the extension in the direction of flow, of the flow chamber, or the flow chamber closing and diaphragm clamping flange, is shorter than the extension in the direction transverse to the flow direction.

According to a preferred embodiment of the invention, which will be described in greater detail in the explanation of the drawings, from the respective free ends to the ends that open into the flow chamber, the two sleeves may have a cross section that

progressively widens in a direction transverse and perpendicular to the flow direction and parallel to the separation plane between the two chamber parts, and progressively narrows in a direction substantially coincident with the bending radius of each sleeve so that the flow chamber port, at the flange of the chamber part integrated in the valve body, has a shape that is flattened in the flow direction and elongated in a direction transverse to said flow direction, and particularly has a substantially elliptic shape, or anyway inscribable in a peripheral, substantially rectangular clamping flange, with the longer side disposed transverse to the flow direction. The peripheral flange of the diaphragm may have a corresponding rectangular shape. The drastic reduction of the axial size of the flow chamber port, which is obtained by using an elliptic shape, allows to reduce the size and space requirements of the valve in the axial direction, which are generally more problematic than in the transverse direction. Furthermore, the use of a diaphragm having a dome with the shape of a sector of an ellipsoid prevents the latter from bowing out into the outlet sleeve port, thanks to the small extension of the arc of said sector of ellipsoid, which corresponds to the smaller diameter of the section plane thereof and thanks to the small axial size of said outlet sleeve port, which is "narrower". The flow rate is maintained by correspondingly increasing the transverse size of the flow chamber port. By reducing the radius of the dome-shaped portion of the diaphragm

in the direction of flow, the resiliency of the diaphragm is considerably enhanced, in the idle, unstressed condition, i.e. when its convexity is oriented toward the valve seat. As is known, in the opened condition, the dome shape may be completely inverted, i.e. either more flattened or slightly bowed out toward the bonnet.

According to an improvement, the dome-shaped part of the diaphragm may have one or more stiffening ribs, to enhance the resiliency of the dome from the condition in which it is deformed toward the bonnet to the normal unstressed condition, with the convexity being oriented toward the valve seat. These ribs may also have the function of preventing the dome from bowing out, when it is compressed against the valve seat.

Particularly, stiffening and/or elastic or spring-like ribs may be provided on the concave side facing toward the bonnet of the diaphragm dome. An advantageous arrangement of the inventive ribs provides that a plurality of ribs are oriented in the flow direction or in the direction of the shorter axis of the diaphragm dome, a median rib being possibly provided in the direction transverse to the flow or along the longer axis of the diaphragm. The ribs improve resiliency over the whole geometry of the dome, but the shorter rib, oriented in the flow direction, also contributes, in combination with a smaller extension of the port in the direction of the shorter axis, to further prevent the dome from bowing out into

the outlet sleeve port.

Also, two more ribs may be provided on the concave side of the diaphragm dome, which faces toward the bonnet, to connect the center of the dome with the substantially median area of each of the four sections into which the arcuate periphery of the dome base is divided by the axis of the longer diameter and the axis or shorter diameter of the section plane of the sector of ellipsoid which forms the dome.

By combining the above arrangements, the additional advantage is obtained of avoiding the presence, as often provided in prior art valves, of an elastic dome preloading element, like a spring or the like, whose function was to enhance the resiliency of the dome as it turns from the condition in which it is deformed toward the bonnet to the idle unstressed condition, i.e. with its convexity oriented toward the valve seat. This element is generally provided between the bonnet and the concave surface of the diaphragm dome. An additional considerable advantage consists in that no intermediate axial wall is to be provided, before the outlet sleeve port, for supporting the diaphragm dome in such a manner as to prevent it from bowing out, as mentioned above, and this simplifies construction and provides savings on fabrication costs.

A central stiffening member, particularly having a circular shape, may be provided on the concave side of the diaphragm dome that faces toward the bonnet. This member may also have the function to protect the central portion of the dome, if a preloading member,

such as a spring or the like, is eventually needed, to exert its pressing action on the central area of the concave portion of the diaphragm. This need may arise in particularly heavy operating conditions of the valve.

According to a preferred embodiment, which has a very simple construction, both the ribs and the central stiffening member may consist of local thickened portions of the diaphragm dome wall.

In accordance with an additional improvement, the diaphragm dome may have a constant thickness, whereas at least some of the stiffening ribs, preferably all of them, have a thickness that increases toward the center of the dome so that the latter has an increasing compliance toward the center, i.e. in the valve seat compressing area.

Means may be further provided for holding the periphery of the diaphragm flange in such a manner as to prevent it from sliding along the plane of the clamping flanges of the bonnet and the valve body, and from being extracted from between said clamping flanges.

These retaining means may consist of one or more retaining teeth arranged along the peripheral edge of the diaphragm flange, which extend over the surface of the outer edge of the flanges of the valve body and/or the bonnet with a vertical orientation with respect to the plane of the flanges.

In accordance with a preferred embodiment, these retaining means may consist of two retaining tabs, each

being provided along one of the longer sides of the diaphragm flange edge, particularly in the intermediate area between two through holes into which pins are inserted to hold the flange of the bonnet against the flange of the valve body. Each of these holes may be provided in one of the four corners of the diaphragm flange. These tabs extend over the corresponding surface of the outer edge of the valve body flange with a vertical orientation with respect to the plane of said flange and retain the diaphragm on the longer side thereof, which can be more easily slid out, due to the long distance between the two pins in the direction transverse to the flow.

These diaphragm holding means may further consist of one or more bosses provided on the clamping surface of the bonnet and/or the valve body which, with the two flanges in the coupled condition, compress the corresponding portion of the diaphragm flange thereby further preventing it from being slid out.

According to a preferred embodiment, these retaining means may consist of a continuous projection, particularly having discontinuities in the areas adjacent to the pins, and with a substantially elliptic profile, on the clamping surface of the bonnet flange which, with said flange being pressed against the valve body flange, extends along the substantially elliptic peripheral edge of the diaphragm dome and at a certain distance therefrom.

Means may be also provided for centering the bonnet with respect to the valve body and for laterally

limiting any outward extension of the diaphragm flange, particularly while the dome portion changes from the condition in which its concavity is oriented toward the valve seat to the opposite condition, and vice versa.

These means may consist, for instance, of one or more retaining teeth arranged along the outer peripheral edge of the bonnet flange, which extend over the surface of the outer edge of the valve body flange with a vertical orientation with respect to the plane of the flanges.

Nevertheless, according to a preferred embodiment, these means may consist of a tab that continuously extends along the whole peripheral edge of the bonnet flange, which tab extends over the corresponding surface of the outer edge of the valve body flange, with a vertical orientation with respect to the plane of said flange.

The diaphragm flange may have, on at least one face, preferably on both faces, at least a continuous lip seal, particularly having a substantially elliptic shape, which extends along the peripheral edge of the diaphragm dome and at a certain distance therefrom, which is compressed between the clamping flanges of the bonnet and the valve body, so as to enhance the peripheral sealing features of the diaphragm and to compensate for any flange fabrication tolerances.

A central rounded lip seal may be provided on the convex side of the diaphragm dome, facing toward the valve seat, when the dome is in the unstressed condition, which is disposed along the longer axis of

the section plane of the sector of ellipsoid that forms the dome. When the dome is compressed against said surface of the valve seat, said lip acts as a compliant member, which helps the dome to adhere against said valve seat to prevent any fluid flow from the inlet sleeve to the outlet sleeve.

The invention further relates to a diaphragm valve as described hereinbefore whose shape is particularly suitable to allow to use a plastic material in the manufacture of at least the valve body.

Further characteristics and improvements will form the subject of the dependent claims.

The characteristics of the invention and the advantages derived therefrom will be more apparent from the following detailed description of the annexed drawings, in which:

Fig. 1 is a side exploded view of a preferred embodiment of a valve according to this invention.

Fig. 2 is a top plan view of the valve body of Fig. 1.

Fig. 3 is a side elevational view on the right half and an axial sectional view on the left half, of the valve body of Fig. 1.

Fig. 4 is a central cross sectional view of the valve body of Fig. 1.

Fig. 5 is a cross sectional view of the valve body as taken across line D-D of fig. 2.

Fig. 6 is a top plan view of the diaphragm of the valve as shown in Fig. 1.

Fig. 7 is a sectional view, as taken along the

shorter axis of the diaphragm of Fig. 6.

Fig. 8 is a sectional view, as taken along the longer axis of the diaphragm of Fig. 6.

Fig. 9 is a bottom plan view of the diaphragm of the valve as shown in Fig. 1.

Fig. 10 is a top plan view of the bonnet part of the valve as shown in Fig. 1.

Fig. 11 is a sectional view, as taken along the longer axis, of the bonnet part of Fig. 10.

Fig. 12 is a bottom plan view of the bonnet part of the valve as shown in Fig. 1.

Fig. 13 is a sectional view, as taken along the shorter axis of the bonnet of Fig. 10.

Fig. 14 is a perspective view of a diaphragm valve according to another particular embodiment of the valve, which is specially designed to be made of plastic.

Figs. 15 to 18 are four views, two side views, a top plan view and a bottom plan view, of the valve as shown in Fig. 14.

Fig. 19 is a section taken along line C-C in Fig. 15;

Fig. 20 is a section taken along line B-B in Fig. 15;

Fig. 21 is a cross sectional view of the valve as taken across line A-A of fig. 18.

Referring to the Figures, the valve of the invention comprises a valve body 1, which is shown in a lower position, in Fig. 1, and an upper bell-shaped bonnet. The valve body 1 is composed of an inlet sleeve

3 and an outlet sleeve 4 which have a curved shape and are substantially identical, and converge by a confluence curve that opens into a fluid flow chamber which is upwardly delimited by an open/close diaphragm 5 and is peripherally limited by a flange 101 for pressing the latter against a corresponding peripheral flange 102 of the bonnet 2, for securing the latter onto the valve body 1. The bonnet 2 and the valve body 1 are sealably fastened by means of bolts (not shown) passing through holes 202 and 201 which are formed each at one of the four corners of said two flanges 102, 101 and with the interposition of a peripheral flange 105 of the diaphragm, which also has corresponding holes 205 for the passage of bolts. Each of the two sleeves 3, 4 has, at its respective free end, a substantially circular flange 103, 104 to be pressed against a corresponding flange which is provided along the peripheral edge of the end of a tubular valve fastening duct. It should be noted that, for the purposes hereof, the terms upper and lower will only be referred to the drawings, and that the valve may be obviously mounted in any other position. Similarly, the terms inlet sleeve 3 and outlet sleeve 4 shall be only intended as conventional designations, no predetermined flow direction being provided, as the valve body 1 is perfectly asymmetric.

The two sleeves 3, 4 have, starting from their respective free ends, a circular section which progressively widens in a direction transverse to the flow direction and progressively narrows in a direction

substantially coincident with the bending radius of each sleeve 3, 4, in such a manner that the flow chamber port, corresponding to the inner edge of the flange 101, has a substantially elliptic shape, whereas the clamping flange 101 has a substantially rectangular shape, with the longer side disposed in a direction transverse to the flow direction. The line of intersection of the two sleeves 3, 4, on the opposed sides thereof, forms an intermediate wall 6 which extends transverse to the flow direction and whose flattened and slightly concave upper surface 106, whose concavity is oriented toward the diaphragm 5, forms the valve seat 106, i.e. the surface against which the diaphragm 5 is pressed to prevent any fluid flow therethrough.

The shape of the peripheral flange 105 of the diaphragm 5 substantially corresponds to that of the flange 101 of the valve body 1, and is correspondingly rectangular, and inscribes a central convex part 305, whose convexity is oriented toward the valve seat 106, which is made of a cup- or dome-shaped member, and more particularly of a member having the shape of a sector of an ellipsoid, disposed with its section plane corresponding with the flow chamber port. The clamping flange 102 of the bonnet 2 has a rectangular shape which corresponds to that of the flange 105 of the diaphragm 5 and of the flange 101 of the valve body 1. It shall be noted that the flow rate through the flow chamber is maintained even though the port thereof is narrowed in the flow direction, thanks to the fact that

it is equally widened in a direction transverse to said flow direction.

The valve of the invention has the same operation as prior art valves. When the dome 305 of the diaphragm 5 is compressed against the valve seat 106, any fluid flow is prevented from the inlet sleeve 3 to the outlet sleeve 4 whereas, when the dome 305 is lifted and deformed toward the bonnet, free flow is allowed. The valve that is shown in the Figures is hydraulically operated and the compression of the dome 305 against the valve seat is achieved in a well-known manner, e.g. by using a three-way valve, by supplying a pressurized fluid in the chamber delimited by the diaphragm 5 and the bonnet 2, through an inlet port 302 formed in the bonnet 2, whereas the valve is opened by discharging said pressurized fluid. The fluid to be used is preferably the fluid that flows in the valve and is withdrawn therefrom through an intake 203 formed on the inlet sleeve 3. The outlet sleeve 4 itself has an intake 204 which allows to use the valve in both fluid flow directions. It should be noted that in prior art, when the dome 305 is compressed against the valve seat 106, the dome-shaped part, which extends through the port of the outlet sleeve 4, with the pressurized fluid supplied between the diaphragm 5 and the bonnet 2 pressing against the concave surface thereof, tends to bow out into the outlet sleeve 4, as in this type of valves the outlet sleeve port has a substantially semicircular and the dome has a corresponding relatively long radius in the axial flow direction,

whereas in the inventive valve said radius is much shorter, and prevents the diaphragm from bowing out. Moreover, the overall shape of the diaphragm 5, i.e. a sector of an ellipsoid, improves resiliency over the whole geometry of the dome, when it changes from the opening condition, in which it is deformed toward the bonnet 2, to the normal idle condition, in which its convexity is oriented toward the valve seat 106. Nevertheless, the guiding principle of this invention also advantageously applies to mechanically operated valves using an opening/closing wheel. The enhancement of resiliency of the dome 305 also advantageously allows to avoid the presence of a preloading spring 7, which is typically provided in a central position between the bonnet 2 and the dome 305 and acts thereon by exerting pressure against the valve seat 106. bbbbbNevertheless, whenever this is necessary, the spring 7 may be provided, in which case advantages result from interposing a convex pressure member 8 between the lower end of said spring and the dome 305, whose convexity has the same orientation as the dome 305 when the latter is in the idle condition, which distributes the pressure of the spring 7 over a larger surface as compared with that of the end of the spring 7, and protects the dome 305 from an excessive mechanical stress. It shall be further noted that, thanks to the elliptic port of the flow chamber, the valve has a very small longitudinal size as compared with prior art valves.

The dome 305 has a central stiffening rib 405

oriented along the longer axis, on the concave side facing toward the bonnet 2. Also, one or more transverse ribs 505 are provided perpendicular to said central rib 405 oriented along the longer axis, which ribs extend parallel to the shorter axis of the section plane of the sector of ellipsoid which forms the dome 305. One of the above transverse ribs 505 extends along said shorter axis of the dome that is shaped like a sector of an ellipsoid. The individual transverse ribs are evenly distributed along the extension of the rib 405 which coincides with the longer axis of the dome 305. Any number of transverse ribs may be provided, depending on the extension along the longer axis and/or the shorter axis of the dome 305, even one single transverse rib, for instance the central transverse rib, along the shorter axis of the dome.

A variant embodiment provides, besides the rib 405 oriented along the longer axis, another transverse rib oriented along the shorter axis and one or more ribs which branch off the center and are oriented in such a manner as to divide the four quadrants of the dome 305, which are defined by the longer axis and the shorter axis of the dome 305, into identical or different webs. Both variants provide an additional central stiffening member 605, having a circular shape, which possibly protects against the pressure exerted by the spring 7 in the rare instances in which the latter has to be provided. The ribs 405, 505 further help to enhance the resiliency of the dome 305. Both the ribs 405, 505 and the central stiffening member are obtained by locally

thickening the wall of the dome 305, the thickness of the ribs 405, 505 progressively increasing toward the center of the dome 305, and decreasing substantially correspondingly to the profile of the wall of the dome 305 until they abut against the latter, at a certain distance from the upper edge for connection to the peripheral flat flange 105.

A retaining tab 705 is provided along each longer side of the flange 105 of the diaphragm 5, in an intermediate position between the two through holes 205 for the coupling pins, which tab extends over the corresponding surface of the outer edge of the flange 101 of the valve body 1 and has a vertical orientation with respect to the plane of said flange 101, in such a manner as to hold the periphery of the flange 105 of the diaphragm 5, and prevent it from sliding along the plane of the clamping flanges 102, 102 of the bonnet 2 and the valve body 1 respectively, and from being extracted from between said coupled flanges 102, 101. Furthermore, the flange 105 of the diaphragm 5 has a continuous sealing lip 805, 805' on both faces, which has a substantially elliptic shape and extends along the peripheral edge of the dome 305, at a certain distance therefrom, and is deformed by mutual compression of the two flanges 102, 101 of the bonnet 2 and the body 1 respectively. A central, rounded lip seal 905 is provided on the convex side of the dome 305 facing toward the valve seat 106, in a position corresponding to the longer transverse rib 405 which, with the dome 305 compressed against said valve seat

106, acts as a compliant element and helps the dome 305 to adhere against said seat 106 to prevent any fluid flow from the inlet sleeve 3 to the outlet sleeve 4.

A substantially elliptic projection 402 is provided on the clamping surface of the flange 102 of the bonnet 2, and has discontinuity areas in the proximity of the holes 202 for the coupling pins which projection, when pressed against the flange 101 of the valve body 1, extends along the peripheral edge of the dome 305, and compresses a corresponding portion of the flange 105 of the diaphragm 5, while further preventing it from being pulled out.

The peripheral edge of the flange 102 of the bonnet 2 has a continuous tab that extends over the corresponding surface of the outer edge of the flange 101 of the valve body 1, which has a vertical orientation with respect to the plane of said flange 101 and has the function of centering the bonnet 2 and of laterally limiting any outward extension of the flange 105 of the diaphragm 5.

The diaphragm valve of the invention has the considerable advantage of allowing the use of plastic for in the fabrication of the valve. In prior art, diaphragm valves are made of metal, particularly cast iron. In this case, the fabrication process requires the use of a disposable mold, whereby undercuts cause no problem. The use of plastic in the fabrication of prior art problems involves two problems. First, in the conventional circular diaphragm version, valve sizes do not allow the use of plastic, due to resistance

problems of this material. Further, any structural change of these valves for the purpose of making them of plastic, by using shape arrangements providing a stronger structure, would cause serious problems in terms of plastic valve sizes, as well as an increased mold complexity.

However, the invention allows to conform the valve, particularly the body thereof, in such a manner as to allow it to be made of plastic, without causing any problem regarding sizes and fabrication molds and while further ensuring the required resistance.

The smaller valve sizes provided by this invention allow to manufacture the valve body in such a manner as to ensure small space requirements and to provide the required higher stiffness and mechanical strength.

Figures 14 to 20 show the embodiment of the inventive valve that is specially designed to be made of a plastic material. The inventive concept allowing to reduce the diameter of the diaphragm and the flange for clamping the latter between the valve body and the bonnet is substantially identical to that of the previous embodiment.

However, in plastic valves, instead of the two inlet and outlet sleeves 3, 4 which are curved and widen one toward the other, to form, in the intersecting portion, the arcuate surface that forms both the valve seat 106 and the flow chamber, and whose aperture is flattened in the flow direction, particularly having an elliptic shape that corresponds to the elliptic dome 305 of the diaphragm open/close

element 5, the two sleeves 3, 4 open into two pocket-like chambers 13, 14. The openings of the pocket-like chambers, whose axes are perpendicular to those of the inlet ends of the sleeves 3, 4 form, like in the valve of the previous embodiment, a common aperture, defined by the edge that is flattened in the axial flow direction, and especially elliptic 206, which is surrounded by the flange 101, inscribable in a rectangle, whereto the bonnet 2 may be sealably secured with the interposition of the peripheral flange 105 of the diaphragm open/close element 5. The valve seat 106 consists, like in the previous embodiment, of an arched, saddle-shaped surface, formed by the two opposed walls transverse to the flow direction 113, 114 of the two pockets 13, 14 which end by an upper edge, inwardly arched with respect to the surface of the peripheral flange 101, sloping down from both ends level with the peripheral flange 101 to the central area, with an arched and progressive profile, the edges of said two opposed transverse walls 113, 114 being connected by a flattened connection edge which forms the arched valve seat 106.

It shall be noted that the shape of the two pockets 12, 14 substantially corresponds to half the peripheral edge 206 of the clamping flange 101.

The sleeves 3, 4 extend substantially perpendicular to the outer wall 213, 214 that is parallel or substantially parallel to the opposed walls 113, 114 of the two pockets 13, 14.

The two opposed walls 113, 114 of the two pocket-

like chambers 13, 14 are substantially parallel and diverge at the closed bottom with arched or rounded walls 313, 314 toward the corresponding opposite outer wall 213, 214.

As is apparent, particularly from Figures 16, 17, 19, 20, 21, a number of transverse ribs 15 are provided between the two opposed walls 114, 113 of the two pocket-like chambers 13, 14, which ribs are oriented in the flow direction or along the shorter axis of the flattened or elliptic shape of the edge 206 of the flange 101. The ribs 15 extend in the hollow portion formed by the two facing walls 113, 114 and the outer side of the arched edge that forms the valve seat 106 and progressively widen as the relative distance between the two walls 113, 114 increases, until they end substantially flush with the bottom side of the two pocket-like chambers 13, 14. All, some or only two of the transverse ribs 15 may slightly project out of the bottom side of the pocket chambers 13, 14, thereby forming two support elements, or feet.

The bonnet 2, not shown in detail, is fabricated in the same manner as previously described with reference to Figures 1 to 13. The bonnet may be made of plastic or sheet metal, particularly stainless steel sheet, which is appropriately shaped by a drawing process. The diaphragm itself is unchanged with respect to that described above.

One difference from the previous embodiment, as shown in Figures 1 to 13, consists in that, in the embodiment as shown in Figures 14 to 21, the flanges

101, 105 and 102 of the valve body, of the diaphragm 5 and of the bonnet respectively, have a greater number of through holes for bolt and nut pairs. This is specially necessary for large size valves, as both the sheet metal bonnet and the plastic bonnet that are provided in combination with the flange of the valve body, itself made of plastic, are relatively elastic and might not ensure the required sealing action, especially on the longer side, when only four fastening points are provided at the four corners of the two opposite shorter ends of said flanges.

It shall be noted, regarding the previous embodiment, that no large-sized diaphragm valve is currently known to be made of plastic, the structure thereof being unuitable for this type of material. The novel embodiment of the inventive diaphragm open/close element and, consequently, of the valve body, allows to obviate the technical problems associated with the manufacture of diaphragm valves of plastic.

Obviously, the invention is not limited to the embodiment described and illustrated herein, but the teaching of this invention is applicable to a variety of valve types, both mechanically or hydraulically operated, without departure from the guiding principle disclosed above and claimed below. Hence, for instance, the reduction of valve space requirements as provided by this invention in the flow direction allows to obtain an integrated valve-and-meter device in which, instead of providing a separate meter with means for sealably fitting it onto the inlet sleeve of the valve,

the inlet sleeve of the valve is extended beyond the normal size and is integrated therein or forms itself the housing of a meter part.

Similarly, further operating units may be provided, integral with the valve. The particular reduced size construction of the inventive valve allows the construction of particularly compact integrated devices.